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भारतीय मानक

विद्युत-ध्वानिकी — ध्वनि अंशशोधक

Indian Standard

ELECTROACOUSTICS — SOUND CALIBRATORS

ICS 17.140.50

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 2001 **Price Group 10**

Acoustics Sectional Committee, LTD 5

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 60942 (1997) 'Electroacoustics — Sound calibrators', issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of Acoustics Sectional Committee (LTD 5) and approval of the Electronics and Telecommunication Division Council.

The text of the IEC Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following.

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Only the English language text in the International Standard has been retained while adopting it in this standard.

CROSS REFERENCES

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050 (801) : 1994 International Electrotechnical Vocabulary (IEV) — Chapter 801: Acoustics and electroacoustics	IS 1885 (Part 3/Sec 2) : 1966 Electrotechnical vocabulary: Part 3 Acoustics, Section 2 Acoustical and electro-acoustical systems	Not equivalent
IEC 61672 Electroacoustics — Sound level meters	IS 9779 : 1981 Sound level meters	do
ISO 266 : 1997 Acoustics — Preferred frequencies	IS 2264 : 1963 Preferred frequencies for acoustical measurements	do

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following International Standards and has decided that they are acceptable for use in conjunction with this standard:

IEC 61094-1 : 1992 Measurement microphones — Part 1: Specifications for laboratory standard microphones

IEC 61094-2 : 1992 Measurement microphones — Part 2: Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique

IEC 61094-3:1995 Measurement microphones — Part 3: Primary method for free-field calibration of laboratory standard microphones by the reciprocity technique

IEC 61094-4:1995 Measurement microphones — Part 4: Specifications for working standard microphones

ISO 14253-1 Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring instruments — Part 1: Decision rules for proving conformance or non-conformance with specifications

ISO Information Publication: 1995, ISBN 92-67-10188-9 Guide to the expression of uncertainty in measurement

IS 15059 : 2001
IEC 60942 (1997)

Indian Standard

ELECTROACOUSTICS — SOUND CALIBRATORS

1 Scope

1.1 This International Standard specifies the performance requirements for three classes of sound calibrator: class 0, class 1, and class 2 in decreasing order of accuracy under specified conditions. Class 0 calibrators are normally used in the laboratory, whilst classes 1 and 2 are considered as calibrators for field use.

1.2 The tolerances in this standard do not include the associated expanded uncertainty of measurement, due to the scarcity of reliable data, particularly for some combinations of sound calibrator and model of microphone. However, maximum permitted expanded uncertainties of measurement are quoted separately in annex A and annex B. The dependence of the expanded uncertainty both on the frequency of the sound calibrator and on the method used to calibrate the microphone used for the measurements is reflected in the maximum permitted expanded uncertainties quoted. Refinement of these maximum permitted expanded uncertainties is expected as further experience is gained and further data become available. This will eventually enable the specification tolerances and maximum permitted expanded uncertainties of measurement to be combined in the main body of the standard.

1.3 Conformance to the specifications of this standard is demonstrated only when the result of a measurement, extended by the expanded uncertainty of measurement, lies fully within the specification tolerances given in this standard extended by the expanded uncertainty of measurement.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(801):1994, *International Electrotechnical Vocabulary (IEV) – Chapter 801: Acoustics and electroacoustics*

IEC 61094-1:1992, *Measurement microphones – Part 1: Specifications for laboratory standard microphones*

IEC 61094-2:1992, *Measurement microphones – Part 2: Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique*

IEC 61094-3:1995, *Measurement microphones – Part 3: Primary method for free-field calibration of laboratory standard microphones by the reciprocity technique*

IEC 61094-4:1995, *Measurement microphones – Part 4: Specifications for working standard microphones*

IEC 61672, *Electroacoustics – Sound level meters*[1]

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[1] To be published.

ISO 266: 1997, *Acoustics – Preferred frequencies*

ISO 14253-1,— *Geometrical product specifications (GPS) – Inspection by measurement of workpieces and measuring instruments – Part 1: Decision rules for proving conformance or non-conformance with specifications* [1]

ISO Information
Publication:1995, *ISBN 92-67-10188-9, Guide to the expression of uncertainty in measurement*

3 Definitions

For the purpose of this International Standard, the following definitions apply. Definitions for other relevant quantities are given in IEC 60050(801).

3.1
sound calibrator
device that generates a sinusoidal sound pressure of specified level and frequency when coupled to specified models of microphone in specified configurations

3.2
specified value of sound pressure level or frequency
sound pressure level or frequency specified in the instruction manual for characterizing a sound calibrator when used with a particular microphone model or configuration, valid for all sound calibrators of the same model under reference conditions

3.3
nominal frequency
a close approximation to the specified value of frequency, often rounded according to ISO 266

3.4
equivalent free-field sound pressure level
sound pressure level of a plane progressive wave having the same frequency as the sound calibrator which produces the same output voltage from a particular microphone configuration as the sound calibrator

3.5
equivalent diffuse-field sound pressure level
sound pressure level of a random incidence sound field having the same frequency as the sound calibrator which produces the same output voltage from a particular microphone configuration as the sound calibrator

3.6
principal sound pressure level
in a multi-level calibrator, a level specified in the instruction manual

3.7
principal frequency
in a multi-frequency calibrator, a frequency specified in the instruction manual

3.8
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to a particular quantity subject to measurement, i.e. a measurand

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[1] To be published.

NOTE 1 – Adapted from ISO 14253-1.

NOTE 2 – The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.

NOTE 3 – Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterised by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.

NOTE 4 – It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

3.9
combined standard uncertainty of a measurement

the result of a measurement when that result is obtained from a number of other quantities, equal to the positive square root of the sum of terms, the terms being variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities

NOTE – Adapted from ISO 14253-1.

3.10
expanded uncertainty of a measurement

quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

NOTE 1 – From ISO 14253-1.

NOTE 2 – The fraction may be viewed as the coverage probability or the level of confidence of the interval.

NOTE 3 – To associate a specific level of confidence with the interval defined by the expanded uncertainty requires explicit or implicit assumptions regarding the probability distribution characterized by the measurement result and its combined standard uncertainty. The level of confidence that may be attributed to this interval can be known only to the extent to which such assumptions may be justified.

3.11
coverage factor, *k*

numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

NOTE – From ISO 14253-1.

3.12
reference standard

device with a calibration directly traceable to national standards

3.13
working standard

device regularly calibrated against a reference standard, used to measure the instrument under test

3.14
replication

complete repeat of a measurement. In this standard a replication involves completely removing the microphone from the calibrator and then re-coupling

3.15
total distortion

unwanted components such as harmonics and noise present in the output of the calibrator, expressed as a percentage of the fundamental sinusoidal output signal

4 Reference environmental conditions

Reference environmental conditions for specifying the performance of a sound calibrator are:

- air temperature: 23 °C;
- static pressure: 101,325 kPa;
- relative humidity: 50 %.

5 Requirements

5.1 General

5.1.1 A sound calibrator conforming to this standard shall have the characteristics described in this clause. In order to accommodate more than one model of microphone, adaptors may be provided. For the purpose of this standard, any such adaptor shall be regarded as forming an integral part of the sound calibrator.

5.1.2 A sound calibrator may provide a single level and a single frequency or several level and frequency combinations. One or more of these shall meet the requirements of this standard, and different combinations may meet different class designations. The combinations available and their class designations, at least for the principal sound pressure level and principal frequency, shall be clearly identified by markings on the sound calibrator, or by an appropriate statement in the instruction manual. Combinations available which do not conform to this standard shall be identified in the instruction manual and their performance parameters and tolerances described.

5.1.3 The sound calibrator may incorporate other functions, for example, tonebursts. These other functions are not the subject of this standard but if incorporated they shall be fully described in the instruction manual.

5.1.4 The design of the sound calibrator and the materials used in the construction shall be such as to provide long term stability of the output.

5.1.5 If a specific orientation of the sound calibrator is to be used to meet the requirements of this standard, the orientation shall be specified on the sound calibrator, or in the instruction manual.

5.1.6 All performance requirements relate to the operation of the sound calibrator after any stabilizing time specified in the instruction manual, which shall not exceed 120 s.

5.2 Sound pressure level

5.2.1 General

5.2.1.1 All specified sound pressure level(s) generated shall be stated in the instruction manual with a resolution better than or equal to 0,1 dB. At least one of these, with at least one specified model of microphone, shall be marked or displayed on the sound calibrator. Where the sound calibrator is a multi-level device this shall be the principal sound pressure level.

5.2.1.2 All the requirements and tolerances specified in this standard relate to the level of the sound pressure produced at the diaphragm of the inserted microphone.

5.2.1.3 Equivalent free-field or diffuse-field (random incidence) sound pressure levels may differ from the pressure-field level produced at the diaphragm of the inserted microphone. The difference depends on the geometrical configuration and the electroacoustical characteristics of the microphone and calibrator, the difference and its associated uncertainty increasing with increasing frequency. Where the instruction manual gives either the equivalent free-field or diffuse-field sound pressure level, or both, any difference relative to the pressure-field level produced at the diaphragm of the inserted microphone shall be stated in the instruction manual, together with the expanded uncertainty associated with the difference. In this case all the requirements and tolerances specified in this standard relate also to the equivalent free-field or diffuse-field sound pressure level after application of the appropriate difference for the frequency range from 160 Hz to 1 250 Hz only.

5.2.1.4 One specified sound pressure level of a class 0 or a class 1 sound calibrator shall be at least 90 dB reference 20 µPa when the sound calibrator is applied to one of the models of microphone in the configuration specified in the instruction manual.

5.2.2 Tolerance

The sound pressure level generated by the sound calibrator under the reference environmental conditions given in clause 4, averaged over 20 s of operation, shall not deviate from the corresponding specified value for each particular model of microphone by more than the tolerances given in table 1.

5.2.3 Stability – short-term fluctuations

Fluctuations in the output level about the level determined in accordance with 5.2.2 and measured with time-weighting F (time constant 125 ms, defined in IEC 61672), during 20 s of operation, shall not exceed the stability limits given in table 1.

Table 1 – Tolerance and stability limits on sound pressure level at reference environmental conditions

Calibrator class		0	1	2
Tolerance	dB	±0,15	±0,3	±0,5
Stability	dB	±0,05	±0,1	±0,2

5.3 Frequency

5.3.1 General

5.3.1.1 The nominal or specified frequency or frequencies shall be stated in the instruction manual. At least one of these shall be marked or displayed on the sound calibrator. Where the sound calibrator is a multi-frequency device this shall be the principal frequency.

5.3.1.2 At least one specified frequency generated by the sound calibrator shall be in the range from 160 Hz to 1 250 Hz.

NOTE 1 – It is recommended that all frequencies be selected from the values specified in ISO 266 for the one-third octave series.

NOTE 2 – Where a sound calibrator is specifically intended for use in conjunction with a sound level measuring device, it is recommended that the frequency be 1 kHz.

5.3.1.3 Where the sound calibrator is a multi-level and multi-frequency device it shall be capable of generating the principal frequency at the principal sound pressure level.

5.3.2 Tolerance

The frequency of the sound generated by the sound calibrator under the reference environmental conditions given in clause 4, averaged over 20 s of operation, shall not deviate from the corresponding specified value by more than the tolerances given in table 2.

5.3.3 Stability – short-term fluctuations

Fluctuations in the frequency about the value determined in accordance with 5.3.2 and measured using a time-window of 1 s, during 20 s of operation, shall not exceed the stability limits given in table 2.

Table 2 – Tolerance and stability limits on output frequency at reference environmental conditions

Calibrator class		0	1	2
Tolerance	%	±1	±2	±4
Stability	%	±0,3	±0,5	±1

5.4 Influence of static pressure, temperature and humidity

5.4.1 Sound calibrators shall operate within the limits given in table 3 and table 4, relative to the values measured in 5.2.2, 5.2.3, 5.3.2 and 5.3.3, over a range of ambient conditions as follows:

– static pressure:	65 kPa to 108 kPa
– ambient temperature:	–10 °C to +50 °C
– relative humidity:	10 % to 90 %

unless the more limited conditions of 5.4.3 apply.

This requirement applies with one of the parameters varied over the range, and the other two held at reference environmental conditions, and in addition applies to the specific combinations of conditions described in 5.4.6 and 5.4.7.

5.4.2 Sound calibrators for which the performance is within these limits shall be designated class 0, 1 or 2 as appropriate. The designation may differ for different frequencies or levels.

5.4.3 Sound calibrators which only meet the tolerances of table 3 and table 4 over the following limited range of conditions:

– static pressure:	85 kPa to 105 kPa
– ambient temperature:	+5 °C to +35 °C
– relative humidity:	30 % to 80 %

shall have the letter L added to their class designation.

5.4.4 Sound calibrators which perform within the tolerance limits of table 3 and table 4 over the full range of environmental conditions specified in 5.4.1 or the limited range of environmental conditions specified in 5.4.3, but which require corrections for any of the ambient conditions to achieve the requirements specified in tables 3 and 4, shall have the letter C added to their class designation. These corrections, together with their associated uncertainties, shall be given in the instruction manual. Either a means of measuring the relevant ambient condition shall be supplied with the sound calibrator, or a statement shall be included in the instruction manual giving the tolerance within which the ambient condition shall be measured to achieve results within the requirements for the appropriate class.

5.4.5 In summary, the class designations are as follows:

Class 0, 1, 2	performance meeting requirements of this standard over full environmental range without corrections.
Class 0L, 1L, 2L	performance meeting requirements of this standard over limited environmental range without corrections.
Class 0C, 1C, 2C	performance meeting requirements of this standard over full environmental range with corrections.
Class 0LC, 1LC, 2LC	performance meeting requirements of this standard over limited environmental range with corrections.

5.4.6 Sound calibrators with letter designation C alone or no letter designation shall also conform to the tolerances in table 3 and table 4 for the following combinations of temperature and relative humidity:

- a temperature of 5 °C and relative humidity of less than 40 %;
- a temperature of 40 °C and relative humidity of 90 %.

Corrections shall be applied if appropriate when the calibrator has a C letter designation.

5.4.7 Sound calibrators with letter designation L or LC shall also conform to the tolerances in table 3 and table 4 for the following combinations of temperature and relative humidity:

- a temperature of 5 °C and relative humidity of less than 40 %;
- a temperature of 35 °C and relative humidity of 80 %.

Corrections shall be applied if appropriate when the calibrator has a C letter designation.

Table 3 – Tolerance on sound pressure level over range of ambient conditions relative to the sound pressure level measured at reference environmental conditions, and stability limits on sound pressure level over range of ambient conditions

Calibrator class		**0**	**1**	**2**
Tolerance	dB	±0,15	±0,3	±0,5
Stability	dB	±0,05	±0,1	±0,2

Table 4 – Tolerance on output frequency over range of ambient conditions relative to the output frequency measured at reference environmental conditions, and stability limits on output frequency over range of ambient conditions

Calibrator class		**0**	**1**	**2**
Tolerance	%	±1	±2	±4
Stability	%	±0,3	±0,5	±1

5.5 Total distortion

The total distortion (over the frequency range from 20 Hz to 20 kHz) of the sinusoidal sound pressure generated by the sound calibrator shall not exceed 2 % for class 0 sound calibrators and 3 % for class 1 and class 2 sound calibrators, over the appropriate range of environmental conditions for the designation of the sound calibrator.

5.6 Battery requirements

If the sound calibrator is battery operated, the manufacturer shall provide as an integral part of the sound calibrator some means of checking that the battery voltage is sufficient to operate the sound calibrator in accordance with this standard or shall ensure that the sound calibrator ceases to produce any sound output when the battery voltage falls below the level required to operate the sound calibrator in accordance with this standard. The preferred battery type shall be indicated on, or as close as possible to, the battery compartment.

5.7 Specification of microphone models

5.7.1 Microphone models and adaptors

The instruction manual for the sound calibrator shall state the microphone configuration as designated in IEC 61094-1 or IEC 61094-4, and/or the brand name, model designation and configuration of those microphones with which the sound calibrator is designed to operate and conform to this standard. In each case, the required adaptor configuration (if any) shall be given and the specified value of the sound pressure level produced at the microphone stated. For class 0 sound calibrators at least one of the microphone types specified shall be a laboratory standard microphone as defined in IEC 61094-1, capable of being calibrated in accordance with IEC 61094-2. For class 1 and class 2 sound calibrators it is recommended that the dimensions of the sound calibrator cavity (with an adaptor if necessary) are such that it will accept a microphone with dimensions as described in IEC 61094-1. A microphone of these dimensions can then be used for the environmental tests specified in 5.4. If the sound calibrator and adaptors are such that they will not accept a microphone with these dimensions, then the instruction manual shall state the pressure, temperature and relative humidity coefficients, together with the associated expanded uncertainties, for a model of microphone typically used with the sound calibrator. This model of microphone can then be used for the environmental tests specified in 5.4.

5.7.2 Microphone calibration

The microphone types specified shall be capable of calibration by at least one of the following methods:

a) a method specified in IEC 61094-2 or IEC 61094-3;

b) by comparison with a calibrated laboratory standard microphone, the instruction manual specifying the method to be used for the comparison;

c) for class 1 and class 2 sound calibrators, by calibrating the microphone with a calibrated class 0 sound calibrator as specified in this standard, operating at the required frequency.

5.8 Electromagnetic compatibility

Under consideration.

6 Marking and instruction manual

6.1 Marking of the sound calibrator

Sound calibrators conforming to this standard shall be provided with the following minimum information which shall be marked or displayed on the sound calibrator:

a) manufacturer's or supplier's name or trademark;

b) model designation and serial number;

c) reference to this standard by number and publication date;

d) the class of instrument, including the L and C letter designation where appropriate; for multi-frequency and/or multi-level calibrators the class at the principal frequency and level. At other frequencies and levels the sound calibrator shall either be marked with the class designation or reference shall be made to the instruction manual;

e) at least one of the specified value(s) of sound pressure level(s) for at least one model of microphone; where the sound calibrator is a multi-level device this shall be the principal sound pressure level;

f) the nominal or specified frequency or frequencies.

Adaptors, where provided, shall be clearly marked with their model designations.

6.2 Instruction manual

The sound calibrator shall be provided with an instruction manual which, as a minimum, shall contain the information required by all the subclauses of clause 5 and by 6.1. It shall also contain the following information:

a) full identification of the microphone models (and of the configurations in which they are used) with which the sound calibrator is designed to operate and of the relevant adaptors required, together with detailed instructions which need to be followed to ensure that in use the sound calibrator meets this standard;

b) specified value(s) of sound pressure level(s) and frequency(ies) when the sound calibrator is coupled to the specified microphone models and configurations;

c) if a specific orientation of the sound calibrator is to be used to meet the requirements of this standard, the orientation shall be specified on the sound calibrator, or in the instruction manual;

d) the stabilizing time before the sound output reaches the level specified;

e) the principal sound pressure level for multi-level devices;

f) the principal frequency for multi-frequency devices;

g) the range of environmental conditions over which the sound calibrator is designed to operate, and the correction data specified in 5.4, together with the expanded uncertainties associated with the correction data;

h) a statement of the ambient noise level(s) below which the sound calibrator is intended for use;

i) where the instruction manual specifies equivalent free-field and/or diffuse-field levels, the difference between these levels and the pressure-field level produced at the diaphragm of the inserted microphone, together with the expanded uncertainties associated with these differences;

j) for class 0 or 1, including those with L or C or LC letter designations, either the typical effective volume of the sound calibrator plus microphone or the typical change in sound pressure level produced by the sound calibrator for a specified change in effective volume of the attached microphone;

k) types of battery which may be used, if applicable, together with details of any battery status indicator and, where applicable, how an external power supply can be connected, together with the nominal supply voltage(s);

l) where none of the specified models of microphone can be calibrated in accordance with IEC 61094-2 or IEC 61094-3, sufficient detail of the comparison method to be used for calibration of at least one of the specified models of microphone in the configuration in which it is used, with a microphone calibrated in accordance with IEC 61094-2 or IEC 61094-3 (see 5.7);

m) for a class 1 or class 2 sound calibrator, where the dimensions of the calibrator cavity (with an adaptor if necessary) are such that it will not accept a microphone with dimensions as described in IEC 61094-1, the pressure, temperature and relative humidity coefficients, together with the associated expanded uncertainties, for a model of microphone typically used with the sound calibrator;

n) where a barometer or thermometer is required but not supplied, details of a suitable device to measure static pressure or temperature, including the expanded uncertainty within which the ambient condition shall be measured to achieve results within tolerance for the relevant class;

o) where a sound calibrator has additional features not specified in this standard, a clear statement to this effect together with details of the manufacturer's specification for these additional features.

Annex A
(normative)

Conformance tests

A.0 Introduction

A.0.1 This annex gives details of the minimum tests necessary to verify all the requirements specified in this standard for sound calibrators. The tests are applicable to all classes of calibrator, and aim to ensure that testing is performed in a consistent manner within all testing laboratories.

A.0.2 Laboratories performing these tests shall calculate the uncertainties associated with all the measurements, in accordance with the guidelines given in the *Guide to the expression of uncertainty in measurement* published by ISO. Expanded uncertainties shall be calculated with a coverage factor of 2, unless the contributions are such that is necessary to use a coverage factor greater than 2 to maintain the same level of confidence.

A.0.3 The maximum expanded uncertainties of measurement given in this annex are the maximum values permitted for demonstration of conformance under this annex to the specifications of this International Standard. The testing laboratory shall apply their actual values of the applicable expanded uncertainties of measurement, provided the actual values do not exceed the maximum permitted values. Tests to demonstrate conformance to the specifications of this International Standard shall not be performed if the actual values of the expanded uncertainties of measurement exceed the maximum permitted values. The testing laboratory shall state the expanded uncertainty for each measurement performed.

A.0.4 Conformance to the specifications of this standard is demonstrated only when the result of a measurement, extended by the expanded uncertainty of measurement, lies fully within the specification tolerances given in this standard extended by the expanded uncertainties of measurement.

A.0.5 In this annex, tables are given for the maximum permitted expanded uncertainty of measurement for the following: sound pressure level tolerance at reference environmental conditions (table A.1); sound pressure level stability at reference environmental conditions (table A.2); tolerance and stability of output frequency at reference environmental conditions (table A.3); total distortion over the appropriate range of environmental conditions (table A.4); sound pressure level tolerance over range of ambient conditions (table A.5); tolerance of output frequency over range of ambient conditions (table A.6). For tables A.1 and A.5 the following applies:

a) where a microphone is capable of calibration in terms of its pressure sensitivity by more than one method, the method available with the smallest measurement uncertainties shall be used;

b) where a microphone is capable of calibration in terms of its free-field sensitivity by more than one method, the method available with the smallest measurement uncertainties shall be used;

c) where a microphone is capable of calibration in terms of either its pressure or free-field sensitivity the method used shall depend on whether an effective free-field level is quoted in the instruction manual;

d) the method described in 5.7.2 c) shall only be used when the microphone is not capable of calibration by any of the methods described in 5.7.2 a) or 5.7.2 b).

A.0.6 The test laboratory shall use instruments with valid calibrations which are traceable to national standards as required.

A.1 Submission for test

Each sound calibrator, together with all relevant accessories (such as adaptors, barometer), shall be submitted for test together with a copy of the instruction manual.

A.2 Specified values

A.2.1 It shall be confirmed that at least one specified value of sound pressure level of classes 0 and 1 sound calibrators is 90 dB reference 20 µPa or greater, when the sound calibrator is applied to the models of microphone in the configurations specified in the instruction manual.

A.2.2 It shall be confirmed that at least one nominal frequency of the sound calibrator is in the range from 160 Hz to 1 250 Hz.

A.3 Marking of the sound calibrator and information in the instruction manual

It shall be verified that the markings on the sound calibrator and the information in the instruction manual supplied meet the requirements and contain all the information specified in 6.1 and 6.2 of this standard.

A.4 Performance tests at nominal reference environmental conditions

A.4.1 Orientation and stabilizing time

A.4.1.1 If a specific orientation of the sound calibrator is marked on the sound calibrator or given in the instruction manual, this mode shall be used for testing.

A.4.1.2 All performance requirements relate to the operation of the sound calibrator after any stabilizing time specified in the instruction manual, which shall not exceed 120 s.

A.4.2 Reference conditions

All tests in clause A.4 shall be carried out within the following range of conditions relative to the reference environmental conditions: within $^{+2,0}_{-4,0}$ kPa of the reference static pressure, within ±1 °C of the reference temperature and within ±20 % relative humidity of the reference relative humidity. For calibrators with letter designation C, data supplied in the instruction manual shall be applied, where appropriate, to correct measurements to the reference environmental conditions.

A.4.3 Power supplies

Except for A.4.4.7, A.4.7.2 and A.4.9.2 all measurements shall be performed at, or within ±5 % of, the nominal voltage of the power supply.

A.4.4 Sound pressure level

A.4.4.1 Following coupling of the microphone to the sound calibrator, time shall be allowed for the microphone and calibrator to stabilize. The sound pressure level generated by the sound calibrator shall then be measured, averaged over 20 s of operation. Where the sound calibrator is a multi-level device, measurements shall be performed at the principal sound pressure level specified in the instruction manual.

A.4.4.2 Measurements shall be performed using models and configurations of microphone specified in the instruction manual. Where the testing laboratory is satisfied that it has reliable evidence of the equivalence of various models of microphone, or of corrections to be applied, it may not be necessary to perform measurements using all models and configurations of microphones, but to use a representative sample of these equivalent models. For class 0 calibrators at least one of these models shall be a laboratory standard microphone as defined in IEC 61094-1. For this microphone model measurements shall be made using the insert voltage technique or an equivalent method. Specifications for other microphone models are given in 5.7 of this standard.

A.4.4.3 Five replications of the measurement of sound pressure level shall be performed. Each value, extended by the expanded uncertainty of measurement, shall not deviate from the corresponding specified value by more than the tolerances given in table 1 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the various combinations of class of sound calibrator and method of calibration of the microphone used are given in table A.1.

A.4.4.4 Measurements of sound pressure level shall be repeated for at least two specimens of each representative model and configuration of microphone for each frequency setting of the sound calibrator above 1 000 Hz for which design certification is sought.

A.4.4.5 For multi-level devices, the sound pressure level generated by the sound calibrator shall also be measured at each level setting for which design certification is sought at each of the frequency settings for which design certification is sought, using one specimen of each representative model and configuration of microphone.

A.4.4.6 The level of ambient noise reaching the microphone during testing shall be at least 30 dB lower than the measured sound pressure level for classes 0 and 1 calibrators, and at least 25 dB lower than the measured sound pressure level for class 2 calibrators.

A.4.4.7 These measurement(s) of sound pressure level shall be repeated (excluding replications) at the minimum operating voltage of the power supply consistent with any battery indicator or sound output cut-off supplied as an integral part of the sound calibrator using one model and configuration of microphone only.

Table A.1 – Maximum permitted expanded uncertainty of measurement of sound pressure level tolerance at reference environmental conditions – applicable to table 1

Calibrator class		0	1	2
Subclause 5.7.2		Expanded uncertainty dB		
a)	where the microphone is capable of calibration in terms of its pressure sensitivity using a method given in IEC 61094-2	±0,07	±0,12 up to 7 000 Hz ±0,15 above 7 000 Hz	±0,15 up to 7 000 Hz ±0,20 above 7 000 Hz
	where the microphone is capable of calibration in terms of its free-field sensitivity using a method given in IEC 61094-3	not applicable	±0,14 up to 1 250 Hz[1)]	±0,20 up to 1 250 Hz[1)]
b)	where the microphone is capable of calibration in terms of its pressure sensitivity **but not using** a method given in IEC 61094-2	not applicable	±0,15 up to 7 000 Hz ±0,20 above 7 000 Hz	±0,25 up to 7 000 Hz ±0,30 above 7 000 Hz
	where the microphone is capable of calibration in terms of its free-field sensitivity **but not using** a method given in IEC 61094-3	not applicable	±0,25 up to 1 250 Hz[1)]	±0,35 up to 1 250 Hz[1)]
c)	where the microphone is calibrated using a calibrated class 0 sound calibrator, operating at the required frequency	not applicable	±0,25 up to 1 250 Hz[1)]	±0,35 up to 1 250 Hz[1)]
and	for diffuse-field calibration of the microphone	not applicable	±0,20 up to 1 250 Hz[1)]	±0,25 up to 1 250 Hz[1)]

[1)] The frequency referred to is a nominal value.

A.4.5 Sound pressure level stability – short term fluctuations

A.4.5.1 Short term fluctuations shall be determined by measuring the maximum and minimum output level over 20 s using time weighting F (defined in IEC 61672). For multi-level and/or multi-frequency devices measurements shall be made at least at the principal sound pressure level and at the principal frequency. The maximum and minimum values, extended by the expanded uncertainty of measurement, shall not differ from the mean value by more than the tolerance for stability given in table 1 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.2.

A.4.5.2 Short term fluctuations shall be measured with one microphone only.

Table A.2 – Maximum permitted expanded uncertainty of measurement of sound pressure level stability at reference environmental conditions – applicable to table 1

Calibrator class		0	1	2
Expanded uncertainty	dB	±0,02	±0,04	±0,06

A.4.6 Free-field and/or diffuse-field levels

If equivalent free-field or diffuse-field levels are quoted for the sound calibrator for specific microphone configurations, it shall be verified that the differences between these levels and the pressure-field level produced at the diaphragm of the inserted microphone are stated correctly in the instruction manual within the expanded uncertainties quoted.

A.4.7 Frequency

A.4.7.1 The frequency of the sound generated by the sound calibrator shall be measured with one of the microphones used in A.4.4, averaged over 20 s of operation, for each frequency setting of the sound calibrator for which design certification is sought. For multi-level devices measurements shall be made at the principal sound pressure level. The measured values, extended by the expanded uncertainty of measurement, shall not deviate from the corresponding specified values by more than the tolerances given in table 2 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.3.

A.4.7.2 These measurements shall be repeated at the minimum operating voltage of the power supply consistent with any battery indicator or sound output cut-off supplied as an integral part of the sound calibrator.

Table A.3 – Maximum permitted expanded uncertainty of measurement of tolerance and stability of output frequency at reference environmental conditions – applicable to table 2

Calibrator class	0	1	2
Expanded uncertainty for tolerance %	±0,15	±0,3	±0,6
Expanded uncertainty for stability %	±0,1	±0,2	±0,3

A.4.8 Frequency stability – short term fluctuations

A.4.8.1 Short term fluctuations shall be determined during 20 s of operation by measuring the frequency of the signal over 20 consecutive 1 s intervals. For multi-level devices measurements shall be made at the principal sound pressure level. Measurements shall be made for each frequency setting of the sound calibrator for which design certification is sought. The maximum and minimum values, extended by the expanded uncertainty of measurement, shall not differ from the mean value by more than the tolerance on stability given in table 2 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.3.

A.4.8.2 Short term fluctuations shall be measured with one microphone only.

A.4.9 Total distortion

A.4.9.1 Total distortion (over the frequency range from 20 Hz to 20 kHz) of the sound pressure level generated by the sound calibrator, shall be measured at the output of the microphone at each frequency setting for which design certification is sought. For multi-level devices measurements shall be made at the principal sound pressure level and at the highest and lowest level settings of the device for which design certification is sought. The total distortion shall be measured with at least one model of microphone. Where possible this microphone shall have a uniform pressure response, and if not, corrections shall be made for the response of the microphone. The measured total distortion, extended by the expanded uncertainties of measurement, shall lie fully within the specification tolerance given in 5.5 of this standard extended by the expanded uncertainty of measurement for the appropriate class of sound calibrator. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.4.

A.4.9.2 These measurements shall be repeated at the minimum operating voltage of the power supply consistent with any battery indicator or sound output cut-off supplied as an integral part of the sound calibrator.

NOTE – Total distortion may be measured using a rejection filter device (distortion factor meter) or an appropriate analyzer.

Table A.4 – Maximum permitted expanded uncertainty of measurement of total distortion over the appropriate range of environmental conditions

Calibrator class	0	1	2
Expanded uncertainty (% distortion)	±0,7	±0,7	±1,0

A.5 Environmental tests

If the instruction manual specifies a battery of particular model and manufacture, such a battery shall be fitted to the sound calibrator for the environmental tests.

A.5.1 Influence of static pressure

A.5.1.1 The sound pressure level and frequency generated by the sound calibrator shall be measured over the applicable range of static pressure. Where the calibrator is a multi-level and/or multi-frequency device, measurements shall be performed at the principal sound pressure level setting and at the highest level setting for which design certification is sought, at all the frequency settings for which design certification is sought. Measurements shall be performed using one specified model and configuration of microphone for which pressure and temperature coefficients are known over the required range. Measurements shall be made at an appropriate number of points over the static pressure range, depending on the sound calibrator under test, the sound calibrator being left to acclimatize for 10 min at each static pressure prior to measurements. Two measurements shall be performed at each point – one with ascending pressure, and one with descending pressure, and the arithmetic mean value taken at each of the points, except at the maximum and minimum static pressure where only one measurement shall be made.

A.5.1.2 Measurements of sound pressure level and frequency shall be performed using the method specified in A.4.4 (excluding replications) and A.4.7, static pressure shall be measured using a calibrated pressure gauge with traceability to national standards, which shall enable the static pressure to be measured with an expanded uncertainty of 0,2 kPa for a coverage factor $k = 2$. During the measurements, the temperature shall be kept constant as far as possible, preferably within ±2 °C of the reference temperature. The relative humidity at the reference static pressure shall be within ±20 % relative humidity of the reference relative humidity. For sound calibrators with a letter designation C, data supplied in the instruction manual (including any pressure coefficient) shall be applied, where appropriate, to correct measurements to the reference environmental conditions. Where applicable, a correction shall be applied to the microphone sensitivity to take account of the pressure coefficient of the measurement microphone itself.

A.5.1.3 Total distortion shall be measured using the method specified in A.4.9 at the lowest static pressure.

A.5.1.4 Relative to the values measured in A.4.4, A.4.7 and A.4.9, the range of static pressure over which

- the measured sound pressure level, extended by the expanded uncertainty of measurement, is within the tolerances given in table 3 extended by the expanded uncertainty of measurement

- the measured frequency, extended by the expanded uncertainty of measurement, is within the tolerances given in table 4 extended by the expanded uncertainty of measurement

and

- the measured total distortion, extended by the expanded uncertainty of measurement, lies fully within the specification tolerance given in 5.5 extended by the expanded uncertainty of measurement

shall be at least as wide as that specified in the instruction manual for the appropriate class of calibrator. Maximum permitted expanded uncertainties of measurement are given in table A.5 for the various combinations of class of sound calibrator and method of calibration of the microphone used, and in tables A.6 and A.4 respectively for the appropriate class of sound calibrator.

NOTE 1 – Where the pressure dependence of the device is not known to follow an established law, it is recommended that measurements should be made at a minimum of seven points over the static pressure range.

NOTE 2 – If the testing laboratory judges that the 10 min acclimatization time specified is inadequate, this time may be increased.

A.5.2 Influence of ambient temperature

A.5.2.1 The sound pressure level and frequency generated by the sound calibrator shall be measured over the applicable range of ambient temperature. Where the calibrator is a multi-level and/or multi-frequency device, measurements shall be performed at the principal sound pressure level setting and at the highest and lowest level settings for which design certification is sought, at all the frequency settings for which design certification is sought. Measurements shall be performed using one specified model and configuration of microphone for which temperature and pressure coefficients are known over the required range. Prior to any measurements, the sound calibrator shall be left, switched off, to stabilize at approximately reference conditions for 12 h. Following this, at each measurement point the sound calibrator and microphone shall be left to acclimatize for 3 h prior to measurements. The microphone shall not be coupled to the calibrator during this acclimatization period. The sequence of measurements is as follows: measurement at the reference temperature, at a temperature between the reference temperature and the maximum temperature specified, at the maximum temperature specified, followed by a reduction to a temperature between the reference temperature and the minimum temperature specified, at the minimum temperature specified and finally at the reference temperature. Measurements shall be made at a minimum of six temperatures at approximately equally spaced intervals over the range. Tolerance on all temperatures is ±1 °C.

A.5.2.2 The measurements of sound pressure level and frequency shall be performed using the method specified in A.4.4 (excluding replications) and A.4.7, and the temperature shall be measured using an appropriate calibrated device with traceability to national standards. During the measurements the static pressure shall be kept constant as far as possible, preferably within $^{+2,0}_{-4,0}$ kPa of the reference static pressure, and the relative humidity shall be kept constant as far as possible at a stated humidity within ±20 % relative humidity of the reference relative humidity. For sound calibrators with a letter designation C, data supplied in the instruction manual (including any temperature coefficient) shall be applied, where appropriate, to correct measurements to the reference environmental conditions. Where applicable, a correction shall be applied to the microphone sensitivity to take account of the temperature coefficient of the measurement microphone itself.

A.5.2.3 Total distortion shall be measured using the method specified in A.4.9 at the lowest and highest temperature.

A.5.2.4 Relative to the values measured in A.4.4, A.4.7 and A.4.9, the range of ambient temperature over which:

- the measured sound pressure level, extended by the expanded uncertainty of measurement, is within the tolerances given in table 3 extended by the expanded uncertainty of measurement
- the measured frequency, extended by the expanded uncertainty of measurement, is within the tolerances given in table 4 extended by the expanded uncertainty of measurement

and

- the measured total distortion, extended by the expanded uncertainty of measurement, lies fully within the specification tolerance given in 5.5 extended by the expanded uncertainty of measurement

shall be at least as wide as that specified in the instruction manual for the appropriate class of calibrator. Maximum permitted expanded uncertainties of measurement are given in table A.5 for the various combinations of class of sound calibrator and method of calibration of the microphone used, and in tables A.6 and A.4 respectively for the appropriate class of sound calibrator.

NOTE 1 – Rapid changes of temperature in the chamber should be avoided.

NOTE 2 – Care should be taken to avoid producing condensation as the temperature of the device is changed.

NOTE 3 – If the testing laboratory judges that the 3 h acclimatization time specified is inadequate, this time may be increased.

A.5.3 Influence of ambient humidity

A.5.3.1 The sound pressure level and frequency generated by the sound calibrator shall be measured over the applicable range of ambient humidity. Where the calibrator is a multi-level and/or multi-frequency device, measurements shall be performed at the highest level setting for which design certification is sought at the principal frequency, and at the highest and lowest frequency settings for which design certification is sought. Measurements shall be performed using one specified model and configuration of microphone whose humidity, pressure and temperature coefficients over the required range are known. Prior to any measurements the sound calibrator shall be left, switched off, to stabilize at approximately reference conditions for 12 h. Following this, at each measurement point the sound calibrator and microphone shall be left to acclimatize for a minimum of 7 h. The microphone shall not be coupled to the calibrator during this acclimatization period. Where the testing laboratory has the facility then to couple the microphone to the calibrator without affecting the relative humidity, measurements can be performed following the period required for pressure equalization due to coupling of the microphone and calibrator. If this is not the case a further acclimatization period of 3 h shall be allowed before commencing measurements. Measurements shall be performed in the following order: at the reference relative humidity, at the maximum humidity applicable, at the reference relative humidity, at 30 % relative humidity, with a tolerance on these nominal values of ±5 % relative humidity.

A.5.3.2 The measurements of sound pressure level and frequency shall be performed using the method specified in A.4.4 (excluding replications) and A.4.7, and the humidity shall be measured using an appropriate calibrated device with traceability to national standards. During the measurements the static pressure and temperature shall be kept constant as far as possible, preferably within $^{+2,0}_{-4,0}$ kPa of the reference static pressure, and within ±2 °C of the reference temperature. For sound calibrators with a letter designation C, data supplied in the instruction manual (including any humidity coefficient) shall be applied, where appropriate, to correct measurements to the reference environmental conditions. Where applicable, a correction shall be applied to the microphone sensitivity to take account of the humidity coefficient of the measurement microphone itself.

A.5.3.3 Relative to the values measured in A.4.4 and A.4.7 the range of ambient humidity over which

- the measured sound pressure level, extended by the expanded uncertainty of measurement, is within the tolerances given in table 3 extended by the expanded uncertainty of measurement and

- the measured frequency, extended by the expanded uncertainty of measurement, is within the tolerances given in table 4 extended by the expanded uncertainty of measurement

shall be at least as wide as that specified in the instruction manual for the appropriate class of calibrator. Maximum permitted expanded uncertainties of measurement are given in table A.5 for the various combinations of class of sound calibrator and method of calibration of the microphone used, and in table A.6 for the appropriate class of sound calibrator.

NOTE – If the testing laboratory judges that the acclimatization time specified is inadequate, this time may be increased.

A.5.4 Influence of temperature and humidity combined

A.5.4.1 The sound pressure level and frequency generated by the sound calibrator shall be measured at the applicable combinations of temperature and relative humidity given in 5.4.6 or 5.4.7. The tolerance on the nominal temperatures is ±2 °C and on nominal relative humidity is ±5 % relative humidity. Where the calibrator is a multi-level and/or multi-frequency device, measurements shall be performed at the principal sound pressure level setting and at the principal frequency only. Measurements shall be performed using one specified model and configuration of microphone whose humidity, pressure and temperature coefficients over the required range are known. Prior to any measurements, the sound calibrator shall be left, switched off, to stabilize at approximately reference conditions for 12 h. Following this, at each measurement point the sound calibrator and microphone shall be left to acclimatize for a minimum of 7 h at the required temperature and humidity. The microphone shall not be coupled to the calibrator during this acclimatization period. Where the testing laboratory has the facility then to couple the microphone to the calibrator without affecting the relative humidity, measurements can be performed following the period required for pressure equalization due to coupling of the microphone and calibrator. If this is not the case, a further acclimatization period of 3 h shall be allowed before commencing measurements.

A.5.4.2 The measurements of sound pressure level and frequency shall be performed using the method specified in A.4.4 (excluding replications) and A.4.7 and the temperature and humidity shall be measured using appropriate calibrated devices with traceability to national standards. During the measurements the static pressure shall be kept constant as far as possible, preferably within $^{+2,0}_{-4,0}$ kPa of the reference static pressure. For sound calibrators with a letter designation C, data supplied in the instruction manual (including any temperature and humidity coefficients) shall be applied, where appropriate, to correct measurements to the reference environmental conditions. Where applicable, a correction shall be applied to the microphone sensitivity to take account of the temperature and humidity coefficients of the measurement microphone itself.

A.5.4.3 Relative to the values measured in A.4.4 and A.4.7:

- the measured sound pressure level, extended by the expanded uncertainty of measurement, shall lie fully within the tolerances given in table 3 extended by the expanded uncertainty of measurement

and

- the measured frequency, extended by the expanded uncertainty of measurement, shall lie fully within the tolerances given in table 4 extended by the expanded uncertainty of measurement

for the appropriate class of calibrator for both combinations of temperature and humidity. Maximum permitted expanded uncertainties of measurement are given in table A.5 for the various combinations of class of sound calibrator and method of calibration of the microphone used, and in table A.6 for the appropriate class of sound calibrator.

Table A.5 – Maximum permitted expanded uncertainty of measurement of sound pressure level tolerance over range of ambient conditions – applicable to table 3

Calibrator class		0	1	2
Subclause 5.7.2		Expanded uncertainty dB		
a)	where the microphone is capable of calibration in terms of its pressure sensitivity using a method given in IEC 61094-2	±0,10	±0,14 up to 7 000 Hz ±0,17 above 7 000 Hz	±0,20 up to 7 000 Hz ±0,25 above 7 000 Hz
	where the microphone is capable of calibration in terms of its free-field sensitivity using a method given in IEC 61094-3	not applicable	±0,16 up to 1 250 Hz[1]	±0,25 up to 1 250 Hz[1]
b)	where the microphone is capable of calibration in terms of its pressure sensitivity **but not using** a method given in IEC 61094-2	not applicable	±0,20 up to 7 000 Hz ±0,25 above 7 000 Hz	±0,30 up to 7 000 Hz ±0,35 above 7 000 Hz
	where the microphone is capable of calibration in terms of its free-field sensitivity **but not using** a method given in IEC 61094-3	not applicable	±0,30 up to 1 250 Hz[1]	±0,40 up to 1 250 Hz[1]
c)	where the microphone is calibrated using a calibrated class 0 sound calibrator, operating at the required frequency	not applicable	±0,30 up to 1 250 Hz[1]	±0,40 up to 1 250 Hz[1]
and	for diffuse-field calibration of the microphone	not applicable	±0,25 up to 1 250 Hz[1]	±0,30 up to 1 250 Hz[1]

[1] The frequency referred to is a nominal value.

Table A.6 – Maximum permitted expanded uncertainty of measurement of tolerance of output frequency over range of ambient conditions – applicable to table 4

Calibrator class		0	1	2
Expanded uncertainty	%	±0,15	±0,3	±0,6

A.5.5 Electromagnetic compatibility

Under consideration.

A.5.6 Additional equipment

A.5.6.1 If a barometer is provided with the sound calibrator it shall be compared, at a temperature within ±2 °C of the reference temperature, with a calibrated precision barometer over the range of static pressures specified in the instruction manual. The accuracy and graduations of the barometer shall be such that corrected values of sound pressure level are within the tolerances given in table 3. The maximum expanded uncertainty in the measured value of static pressure required to meet these tolerances shall agree with that specified in the instruction manual. If the barometer is graduated only in terms of decibels, then its accuracy shall be such that corrected values of sound pressure level are within the tolerances given in table 3.

A.5.6.2 If the sound calibrator does not have a letter designation L, the barometer shall also be compared with a calibrated precision barometer at a temperature of 40 °C ± 2 °C at a static pressure in the range $101{,}325\,^{+2{,}0}_{-4{,}0}$ kPa.

A.5.6.3 If the sound calibrator has a letter designation L, the barometer shall also be compared with a calibrated precision barometer at a temperature of 35 °C ± 2 °C at a static pressure in the range $101{,}325\,^{+2{,}0}_{-4{,}0}$ kPa.

A.5.6.4 For A.5.6.2 and A.5.6.3, the accuracy and graduations of the barometer shall be such that corrected values of sound pressure level are within the tolerances given in table 3. If the barometer is graduated only in terms of decibels, then its accuracy shall be such that corrected values of sound pressure level are within the tolerances given in table 3.

A.5.6.5 If a thermometer is provided with the instrument, it shall be compared with a calibrated device over the range of temperatures specified for the sound calibrator in the instruction manual. Its accuracy and graduations shall be such that corrected values of sound pressure level are within the tolerances given in table 3.

Annex B
(normative)

Periodic tests

B.0 Introduction

B.0.1 This annex gives details of the minimum limited tests necessary to verify the requirements specified in this standard for sound calibrators on a regular basis. The tests are applicable to all classes of calibrator, and aim to ensure that testing is performed in a consistent manner within all testing laboratories.

B.0.2 Laboratories performing these tests shall calculate the uncertainties associated with all the measurements, in accordance with the guidelines given in the *Guide to the expression of uncertainty in measurement* published by ISO. Expanded uncertainties shall be calculated with a coverage factor of 2, unless the contributions are such that is necessary to use a coverage factor greater than 2 to maintain the same level of confidence.

B.0.3 The maximum expanded uncertainties of measurement given in this annex are the maximum values permitted for demonstration of conformance under this annex to the specifications of this International Standard. The testing laboratory shall use their actual values of the applicable expanded uncertainties of measurement, provided they do not exceed the maximum permitted values. Conformance to the specifications of this International Standard shall not be performed if the actual values of the expanded uncertainties of measurement exceed the maximum permitted values. The testing laboratory shall state the expanded uncertainty for each measurement performed.

B.0.4 Conformance to the specifications of this standard is demonstrated only when the result of a measurement, extended by the expanded uncertainty of measurement, lies fully within the specification tolerances given in this standard extended by the expanded uncertainty of measurement.

B.0.5 The maximum permitted expanded uncertainties of measurement given in the tables in annex A apply for measurements performed under annex B, with the exception of the maximum permitted expanded uncertainty of measurement for sound pressure level tolerance. For annex B, the maximum permitted limits given in table A.1 for sound pressure level tolerance are extended by 0,03 dB for a class 0 sound calibrator and by 0,05 dB for a class 1 or class 2 sound calibrator. Other relevant tables are for sound pressure level stability (table A.2), for tolerance and stability of output frequency (table A.3) and for total distortion (table A.4).

B.0.6 The test laboratory shall use instruments with valid calibrations which are traceable to national standards as required.

B.0.7 For the purpose of this annex, it is assumed that the model of sound calibrator under test has passed, or is capable of passing, the full test procedure described in annex A of this standard for the appropriate class.

B.1 Submission for test

The sound calibrator, together with all relevant accessories (such as adaptors, barometer), shall be submitted for test together with a copy of the instruction manual.

B.2 Preliminary inspection

Prior to any measurements the device and all accessories shall be visually inspected, and any controls operated to ensure that they are in working order. It shall be established that the instrument power supply is within the operating limits specified in the instruction manual, by using the method specified in the instruction manual.

B.3 Performance tests

B.3.1 Orientation and stabilizing time

B.3.1.1 If a specific orientation of the sound calibrator is marked on the sound calibrator or given in the instruction manual, this mode shall be used for testing.

B.3.1.2 All performance requirements relate to the operation of the sound calibrator after any stabilizing time specified in the instruction manual, which shall not exceed 120 s.

B.3.2 Environmental conditions

All tests in clause B.3 shall be carried out within the following range of environmental conditions: 85 kPa to 105 kPa, 15 °C to 25 °C and 30 % to 80 % relative humidity. For calibrators with letter designation C, data supplied in the instruction manual shall be applied, where appropriate, to correct measurements to the reference environmental conditions.

B.3.3 Sound pressure level

B.3.3.1 Following coupling of the microphone to the sound calibrator, time shall be allowed for the microphone and calibrator to stabilize. The sound pressure level generated by the sound calibrator when coupled to a specified model and configuration of microphone shall then be measured, averaged over 20 s of operation. Where the calibrator is a multi-level and/or multi-frequency device, measurements shall be performed at the principal sound pressure level and principal frequency specified in the instruction manual. The microphone shall either be a laboratory standard microphone as defined in IEC 61094-1 or capable of calibration according to 5.7.2. In addition, calibration of the microphone by the model of calibrator under test is permitted only if the model of calibrator has previously undergone testing according to annex A and conforms to this standard, and the specimens of sound calibrator in use have undergone testing according to this annex and conform to this standard.

B.3.3.2 Measurements shall be made using the insert voltage technique or equivalent method, or by using a comparison method. The working standard shall be checked against the reference standard prior to and following any measurements made in accordance with this annex.

B.3.3.3 At least three, and preferably five replications of the measurement of sound pressure level shall be performed. Each value, extended by the expanded uncertainty of measurement, shall not deviate from the corresponding specified value by more than the tolerances given in table 1 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. For class 0 sound calibrators the maximum permitted expanded uncertainties of measurement are those given in table A.1 extended by 0,03 dB. For class 1 and class 2 sound calibrators the maximum permitted expanded uncertainties of measurement are those given in table A.1 extended by 0,05 dB.

B.3.3.4 For multi-frequency devices, measurements of sound pressure level according to B.3.3.3 shall be repeated for the highest and lowest frequency settings of the sound calibrator for which design certification has been granted. Where the sound calibrator has not undergone design evaluation tests demonstrating conformance with this standard, the frequency settings used shall be given in the certificate.

B.3.3.5 In addition, for multi-level and/or multi-frequency devices a single measurement of the sound pressure level shall also be made for all other combinations of level and frequency settings for which design certification has been granted. Where the sound calibrator has not undergone design evaluation tests demonstrating conformance with this standard, the level and frequency settings used shall be given in the certificate.

B.3.3.6 The level of ambient noise reaching the microphone during testing shall be at least 30 dB lower than the measured sound pressure level for class 0 and class 1 sound calibrators, and at least 25 dB lower than the measured sound pressure level for class 2 sound calibrators.

NOTE 1 – In cases where the working standard device does not operate at the same level and frequency as the instrument under test, it will be necessary for the testing laboratory to establish the linearity of the measuring system used over the necessary range.

NOTE 2 – Testing will normally be performed for one model and configuration of microphone only. The customer may request that other models/configurations be included.

NOTE 3 – The model and configuration of microphone used for each subsequent verification should preferably be the same as for any previous verification. Provided no sensitivity adjustments have been made to the sound calibrator, this enables information to be obtained on the longer-term stability.

NOTE 4 – The test laboratory should take into account the ambient noise level reaching the microphone as this may affect the uncertainty of measurement.

B.3.4 Sound pressure level stability – short term fluctuations

Short term fluctuations shall be determined by measuring the maximum and minimum output level over 20 s using time weighting F (defined in IEC 61672). For multi-level and/or multi-frequency devices measurements shall be made at least at the principal sound pressure level and at the principal frequency. The maximum and minimum values, extended by the expanded uncertainty of measurement, shall not differ from the mean value by more than the tolerance for stability given in table 1 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.2.

B.3.5 Frequency

The frequency of the sound generated by the sound calibrator shall be measured with the microphone used in B.3.3, averaged over 20 s of operation, for each frequency setting of the sound calibrator for which design certification has been granted. Where the sound calibrator has not undergone design evaluation tests demonstrating conformance with this standard, the frequency settings used shall be given in the certificate. For multi-level devices measurements shall be made at the principal sound pressure level. The measured values, extended by the expanded uncertainty of measurement, shall not deviate from the corresponding specified values by more than the tolerances given in table 2 (for the appropriate class of sound calibrator) extended by the expanded uncertainty of measurement. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.3.

B.3.6 *Total distortion*

Total distortion (over the frequency range 20 Hz to 20 kHz) of the sound pressure level generated by the sound calibrator shall be measured at the output of the microphone used in B.3.3 at the highest level setting of the device for which design certification has been granted and at each frequency setting for which design certification has been granted.

Where the sound calibrator has not undergone design evaluation tests demonstrating conformance with this standard, the level and frequency settings used shall be given in the certificate. Where possible the microphone used shall have a uniform pressure response, and if not, corrections shall be made for the response of the microphone. The measured total distortion, extended by the expanded uncertainty of measurement, shall lie fully within the specification tolerance given in 5.5 of this standard extended by the expanded uncertainty of measurement for the appropriate class of sound calibrator. Maximum permitted expanded uncertainties of measurement for the appropriate class of sound calibrator are given in table A.4.

NOTE — The total distortion may be measured with a rejection filter device (distortion factor meter) or an appropriate analyzer.

B.3.7 Additional equipment

B.3.7.1 If a barometer is provided with the instrument, it shall be compared with a calibrated precision barometer at the static pressure. The reading of the barometer under test shall be noted, and the barometer adjusted if possible, when necessary.

B.3.7.2 If a thermometer is provided with the instrument, it shall be compared with a calibrated thermometer at the ambient temperature. The reading of the thermometer under test shall be noted.

B.3.7.3 The accuracy of the static pressure and temperature readings from the barometer and/or thermometer supplied with the sound calibrator shall be such that the corrected values of sound pressure level are within the tolerance specified in table 3, the corrections being supplied in the instruction manual.

B.4 Test information

It is recommended that a certificate is issued giving at least the following information:

a) details of the laboratory performing the tests;

b) the name of the manufacturer or supplier and the model number of the sound calibrator;

c) the serial number of the sound calibrator, together with details of any adaptors used;

d) the name of the manufacturer or supplier and the model and configuration of the microphone(s) used;

e) the method of calibration employed;

f) the measured values of the mean sound pressure level(s), corrected to the reference environmental conditions if the calibrator has a letter designation C, together with associated uncertainty(ies) and origin of environmental correction data used, if any;

g) the measured values of the frequency(ies) and total distortion(s), together with associated uncertainty(ies), as appropriate;

h) the environmental conditions at the time the tests were performed;

i) if any adjustments have been made to the sound calibrator or a supplied barometer, any values measured prior to adjustment;

j) a statement that the sound calibrator has been tested as specified in this standard;

k) if the device does conform – a statement that the sound calibrator conforms to the requirements of annex B of this standard for the designated class for the conditions under which the test was performed, with limitations on sound pressure level and frequency if applicable, and a statement that this does not imply that the sound calibrator meets this standard under any other conditions;

l) the date of calibration.

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This Indian Standard has been developed from Doc : No. **LTD 5 (1823)**.

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Prabhat Offset Press, New Delhi-2